Diseases Impact Management of USDA Clonal *Vaccinium* Genebank

J. Postman[a], J. Oliphant and K. Hummer
USDA ARS National Clonal Germplasm Repository
33447 Peoria Road, Corvallis, Oregon 97333
USA

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Abstract

The USDA Agricultural Research Service maintains a diverse collection of *Vaccinium* genotypes at the National Clonal Germplasm Repository (NCGR), a temperate fruit and nut genebank in Corvallis, Oregon. *Vaccinium* species are hosts for two pathogens that occur in the U.S. Pacific Northwest and impact collection management. One is the fungus *Phytophthora ramorum* and the other is Blueberry shock virus (BlShV). *Phytophthora ramorum* is a devastating pathogen of certain oak species and has a very broad host range with varying symptoms including foliar blight in some *Vaccinium* species. *Vaccinium* germplasm must be inspected and certified to be free of this pathogen to protect the U.S. nursery industry and native flora. The pollen-borne BlShV has made it necessary to move the primary *Vaccinium* clonal collection from a field planting to a protected potted collection. More than 600 clonal accessions are maintained in greenhouses or screenhouses, protected from pollinators and other virus vectors. These clonal accessions represent more than 60 unique *Vaccinium* taxa from around the world and include 171 cranberry, 46 lingonberry, 15 lowbush blueberry, and 182 highbush and/or rabbiteye blueberry genotypes. Migration to a protected container collection required the development of a management strategy to maintain plants in a vigorous condition that would provide high quality vegetative growth suitable for propagation. However, tree bark in container growth media is a potential source of *P. ramorum* dissemination. Trials were conducted to select a bark-free medium with good fertility and porosity that would be stable for an expected 8-10 year lifespan of a potted blueberry plant. A blend of volcanic pumice (50%), un-milled, coarse, sphagnum peat moss (40%), and sandy loam (10%) was selected. A 3-5 cm deep pumice top-dress (collar) was added to the surface of each pot to create a semi-sterile, dry, inorganic surface that prevents weed, moss, and fungus gnat growth. This top-dress combined with a stable, bark-free potting medium creates a growing system that greatly reduces water use, nutrient leaching, salt build-up, and moisture stress. Woody *Vaccinium* clones are hard-pruned in late winter to remove all flower buds and six to eight upright shoots are selected and allowed to grow. These shoots provide cuttings that are distributed by the genebank for research or propagation.

USDA-ARS VACCINIUM GERMPLASM COLLECTION

The USDA-ARS National Clonal Germplasm Repository in Corvallis, Oregon is one of eight clonal genebanks that preserve horticultural crops for the USDA National Plant Germplasm System (Postman et al., 2006). The *Vaccinium* L. collection at the Corvallis genebank includes more than 600 clonal accessions as potted plants in greenhouses or screenhouses representing 68 unique *Vaccinium* taxa from around the world (Table 1; NPGS, 2008a) with origins in more than 33 countries (Table 2; NPGS, 2008b). Seed collections which number 775 accessions, represent wild *Vaccinium* populations from around the world. Primary clonal collections previously were maintained in field plantings, but due to spread of the pollen-borne *Blueberry shock virus* (BlShV), the primary collection is now maintained under screen where pollinators and

[a] joseph.postman@ars.usda.gov

virus vectors can be excluded. The clonal screenhouse collection includes 171 cranberry, 46 lingonberry, 15 lowbush blueberry, and 182 highbush or rabbiteye blueberry genotypes. *Vaccinium* species from tropical, subtropical, high latitude, and high altitude locations are maintained year-round in greenhouses where they are protected from low winter and high summer temperatures. Flowers and fruit are removed from screenhouse plants, and the plants are pruned and managed for production of propagation material (softwood and hardwood cuttings) for distribution. Young shoot tips are used internally at the genebank for establishment of backup in vitro cultures and for DNA fingerprinting (Boches et al., 2006). Ten percent of the clonal collection is backed up on site as in vitro cultures. A field collection of 346 accessions is used for identity confirmation, fruit evaluation, and for plant phenotype observations. Genebank catalogs, including sub-catalogs for the different crop types such as blueberry, cranberry, and lingonberry, can be found at http://www.ars.usda.gov/pwa/corvallis/ncgr.

Phytophthora ramorum IMPACTS DISTRIBUTION

The fungus *Phytophthora ramorum* Werres, de Cock & Man in't Veld is a devastating pathogen of certain oak species and can also cause a foliar blight in some *Vaccinium* species (Goheen et al., 2002). The sale of infected plants by wholesale nurseries to retail nurseries, and then to home landscapers has played an important role in the dissemination of this pathogen. The species *V. ovatum* Pursh is a natural host, and several other *Vaccinium* species have been easily infected by artificial inoculation (Hansen et al., 2005). Nurseries growing or marketing plants that are potential hosts for *P. ramorum* require annual inspection by the Oregon Department of Agriculture (ODA) for presence of symptoms. Any plants with suspicious symptoms are sampled by ODA and PCR-based laboratory tests are used to determine whether *P. ramorum* is the cause. *Vaccinium* germplasm at NCGR must be inspected and certified to be free of this pathogen to protect the U.S. nursery industry, and plants or cuttings from the genebank sent out of the U.S. must include phytosanitary certification that they are free of this pathogen. With concerns that commercial bark-based nursery growing media may be a potential means of *P. ramorum* dissemination, the NCGR no longer uses these media for germplasm propagation or conservation.

BLUEBERRY SHOCK VIRUS FORCES RELOCATION OF PRIMARY COLLECTION

Prior to 2006, the NCGR field collection was considered the primary genebank for larger, upright, shrub-type *Vaccinium* genotypes. Beginning in 2001, the field collection was tested annually by ELISA for the presence of BlShV after it had been detected at blueberry farms less than 30 km away. BlShV does not kill infected plants, but incites a transient shock reaction that eliminates fruit production for 1-3 years (MacDonald et al., 1991). This pollen-borne virus can be spread by honey bees and other pollinators from infected plantings to healthy plants growing nearby (Bristow and Martin, 1999). In 2005, several infected blueberry plants were detected and removed from the NCGR field planting. In 2006, additional infected plants were detected and rogued. By 2007, the number of infected plants detected indicated that it would be impossible to maintain a field collection free of the virus, and it became necessary to expand the protected screenhouse collection as the primary source of propagation material. Some *Vaccinium* species are present only as seed or in the field planting; however, more than 600 clonal accessions are maintained at NCGR as potted plants in greenhouses or screenhouses, protected from pollinators and other virus vectors.

THE USDA BLEND NO. 2 BARK-FREE GROWING MEDIUM

Migration of the NCGR *Vaccinium* collection to protected potted plants required development of a management strategy to maintain plants in a vigorous condition in order to provide high quality vegetative growth suitable for propagation. Trials were conducted to select a medium with good fertility and porosity that would be stable for an expected 8-

10 year lifespan of a potted blueberry plant. A blend of volcanic pumice (50%), unmilled, coarse, sphagnum peat moss (40%), and sandy loam (10%) was selected. The growing medium is pasteurized at 85° C for 60 minutes prior to use.

A 3-5 cm deep pumice top-dress (collar) was added to the surface of each pot to create a semi-sterile, dry, inorganic surface that prevents weed, moss and fungus gnat growth (Fig. 1; Buamscha and Altland, 2005). This top-dress combined with a stable, bark-free potting medium creates a growing system that greatly reduces water use, nutrient leaching, salt build-up, moisture stress and eliminates the risk of *P. ramorum* contamination. Woody *Vaccinium* clones are hard pruned in late winter to remove all flower buds and six to eight upright shoots are selected and allowed to grow annually as a source of cuttings.

The change to a non-bark-based growing medium for accessions maintained as container-grown plants at NCGR has provided benefits in addition to avoiding the risk of spreading *P. ramorum*. This new medium, in combination with a surface pumice collar, has reduced water use, reduced weeds, reduced pests, and improved fertility. Healthy, vigorous propagating material from the internationally diverse *Vaccinium* collection at NCGR-Corvallis is available to researchers and growers world-wide.

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Tables

Table 1. *Vaccinium* taxa represented at the USDA-ARS genebank at Corvallis, Oregon (NPGS 2008a).

Species	Accessions	Species	Accessions
Vaccinium acrobracteatum	1	*Vaccinium horizontale*	1
Vaccinium ambyandrum *	1	*Vaccinium hybrid*	72
Vaccinium angustifolium	25	*Vaccinium koreanum* *	8
Vaccinium arboreum	35	*Vaccinium laurifolium*	1
Vaccinium arctostaphylos	3	*Vaccinium macrocarpon*	141
Vaccinium boreale	5	*Vaccinium membranaceum*	76
Vaccinium bracteatum	8	*Vaccinium moupinense*	2
Vaccinium caesariense	3	*Vaccinium myrsinites*	7
Vaccinium calycinum *	2	*Vaccinium myrtilloides*	11
Vaccinium cespitosum	11	*Vaccinium myrtillus*	49
Vaccinium chunii *	1	*Vaccinium myrtoides* *	1
Vaccinium consanguineum	2	*Vaccinium neilgherrense* *	3
Vaccinium coriaceum *	1	*Vaccinium oldhamii*	18
Vaccinium cornigerum	1	*Vaccinium ovalifolium*	110
Vaccinium corymbodendron	3	*Vaccinium ovatum*	36
Vaccinium corymbosum	260	*Vaccinium oxycoccos*	80
Vaccinium crassifolium	4	*Vaccinium padifolium*	4
Vaccinium crenatum *	3	*Vaccinium pallidum*	29
Vaccinium cylindraceum	4	*Vaccinium parvifolium*	44
Vaccinium darrowii	48	*Vaccinium phillyreoides*	1
Vaccinium delavayi	3	*Vaccinium praestans*	26
Vaccinium deliciosum *	12	*Vaccinium reticulatum* *	14
Vaccinium dependens	2	*Vaccinium retusum* *	1
Vaccinium elliottii	25	*Vaccinium scoparium* *	21
*Vaccinium emarginatum**	1	*Vaccinium simulatum*	28
Vaccinium erythrocarpum	5	*Vaccinium smallii*	25
Vaccinium erythrocarpum ssp. *japonicum**	3	*Vaccinium sp.*	62
Vaccinium exul	1	*Vaccinium stamineum*	26
Vaccinium floribundum	18	*Vaccinium tenellum*	13
Vaccinium formosum	4	*Vaccinium uliginosum*	94
Vaccinium fuscatum	17	*Vaccinium varingifolium*	2
*Vaccinium glaucoalbum**	1	*Vaccinium virgatum*	67
Vaccinium hirsutum	4	*Vaccinium vitis-idaea*	94
Vaccinium hirtum	7	*Vaccinium vitis-idaea* subsp. *minus*	4

* seed accession only

Table 2. Countries of origin of *Vaccinium spp.* represented at the USDA-ARS genebank at Corvallis, Oregon (NPGS 2008b).

Country	Accessions	Species
Australia	2	1
Bolivia	5	2
Canada	19	8
China	33	7
Colombia	3	2
Costa Rica	1	1
Ecuador	18	3
Finland	35	5
Georgia	6	4
Germany	9	2
India	4	2
Indonesia	1	1
Italy	4	3
Japan	44	12
Korea, South	22	3
New Zealand	3	1
Norway	4	3
Papua New Guinea	2	2
Philippines	1	1
Poland	7	4
Portugal	6	2
Russian Federation	167	10
Slovenia	1	1
South Africa	1	1
Spain	1	1
Sweden	9	5
Switzerland	2	1
Taiwan	1	1
Turkey	2	1
Uncertain	13	10
United Kingdom	11	7
United States	1210	40
Vietnam	1	1
Yugoslavia	1	1

Figure

Fig. 1. Potted ex-situ blueberry accession showing the 3-5 cm deep, water-conserving and pest-reducing pumice collar.